REMARKS/ARGUMENTS

By this amendment, claims 1, 23, and 41 are amended to recite that the p-type semiconductor material has a luminescent peak at about 3.357 eV. Claims 4, 9, and 10 were cancelled without prejudice. Claim 1 was amended to incorporate the subject matter of claim 4. Support for this amendment may be found in the specification, paragraph [0085] and Fig. 3. Claim 41 was amended to correct its dependency and to provide proper antecedent basis for "the amorphous self supporting substrate surface." New claims 42-44 are submitted. New claim 42 is substantially the same as amended claim 23, except that it recites phosphorous as the dopant. Support for this amendment may be found in claim 24 and Fig. 3. Support for new dependent claims 43 and 44 may be found in original claims 29 and 30. Applicants submit no new matter is added by the amendments.

Claim Rejections – 35 USC § 102. Claims 1-9, 11-12, 14-16, 18-20, 22-28, 31-35 and 37-39 were rejected under Section 102(b) as being anticipated by White et al. (U.S. Patent No. 6,291,085, hereinafter "White"). The independent claims have been amended to more particularly define the invention and clearly distinguish the White patent.

The White patent discloses zinc oxide films containing arsenic as a dopant. The White patent discloses electronic characteristics that would be desirable for commercially viable p-type zinc oxide. However, the White patent does not disclose actually making p-type zinc oxide. More importantly, White does not disclose how to make (or actually making) p-type zinc oxide that possesses any of the disclosed electronic characteristics (acceptor concentration, resistivity, Hall mobility, etc.). White discloses making arsenic-doped zinc oxide, but arsenic can be doped in zinc oxide without rendering the resulting material p-type.

White assumes that the mere presence of a p-type dopant requires the film to be p-type, but White does not provide any experimental evidence that proves the films are indeed p-type and possess the physical properties claimed by White. The only evidence provided by White includes the SIMS data of Fig. 3 and the photoluminescence data of Fig. 2. The White patent describes Fig. 2 at column 8, lines 55-58, as follows:

> [T]he arsenic doped ZnO film of the present example shows that the acceptor-bound excitonic peak located at about 3.32 eV (3742 angstroms) is the strongest peak.

No other noticeable photoluminescent peaks are identified or discussed by White.

In contrast, Fig. 3 of the present specification discloses photoluminescent spectra for P-doped zinc oxide and As-doped zinc oxide. Phosphorous doped zinc oxide and arsenic doped zinc oxide both possess a noticeable luminescent peak at about 3.357 eV. This peak is labeled in Fig. 3 and discussed in paragraph [0081]. Both phosphorous and arsenic doped zinc oxide share a second noticeable luminescent peak at about 3.367 eV. This peak is not labeled in Fig. 3. Claims 1, 23, and new claim 42 recite that the p-type zinc oxide semiconductor material has a luminescent peak at about 3.357 eV.

The recent publication, David C. Look, "Electrical and optical properties of p-type ZnO," Semicond. Sci. Technol., **20** (2005), S55-S61, reports photoluminescent properties of p-type zinc oxide and confirms that a noticeable luminescent peak is seen at about 3.367 eV for p-type zinc oxide. A copy of this publication is enclosed herewith.

Given that the arsenic-doped zinc oxide disclosed by White lacks a photoluminescent peak at 3.367 eV, one skilled in the art may reasonably conclude that White's compound is distinctly different than the persistent p-type semiconductor material of the semiconductor devices in accordance with the claimed invention. Indeed, one may even conclude that White's arsenic-doped zinc oxide material is not p-type because it lacks the photoluminescent peak characteristic of p-type zinc oxide.

As mentioned above, zinc oxide can contain a p-type dopant and not possess p-type electronic properties. The Applicants have observed this in the laboratory and identified fabrication method conditions that inhibit the formation of p-type zinc oxide. Applicants disclose limiting the oxygen partial pressure during the deposition process in the specification at paragraph [0045] as follows:

> From a review of the Zn-O-As ternary diagram shown in Figure 17, too much oxygen present may encourage the formation of undesirable ternary compounds,

> such as $Zn_4O_9As_2$, $Zn_3O_8As_2$, $Zn_3O_6As_2$, and ZnO_4As_2. Hence, it is desirable to limit the oxygen partial pressure during the deposition process.

The zinc – oxygen – arsenic ternary diagram reproduced in Fig. 17 identifies several stable and neutral (not p-type) ternary compounds in the upper region of the diagram, including but not limited to, $Zn_4O_9As_2$, $Zn_2O_7As_2$, $Zn_3O_8As_2$, $Zn_3O_6As_2$, and ZnO_4As_2. Each of these compounds has a mole ratio of Zn:O less than one. Zinc oxide, of course, has a mole ratio of Zn:O equal to one. White's fabrication process discloses ablation of polycrystalline zinc oxide in a high purity oxygen atmosphere (about 35 mTorr). Col. 8, lines 32-37. Such process conditions will lead to the formation of ternary compounds having mole ratio of Zn:O less than one, such as the stable and neutral ternary compounds identified in the upper region of the ternary diagram Fig. 17. These compounds are not p-type.

In addition, White's fabrication process discloses annealing the film at a temperature of about 500°C for about 30 minutes. Applicants have observed in the laboratory that arsenic doped p-type zinc oxide may be converted to insulating or n-type zinc oxide when heated to temperatures greater than 460°C. For example, Applicants disclose limiting the annealing temperature of the deposited thin film in the specification at paragraph [0050] as follows:

> In some embodiments, beneficial results have been obtained when the thin film is annealed at a temperature in the range from about 300 to about 450 °C for a time period in the range from about 1 to about 15 minutes.

See also the disclosure at paragraph [0070]. Applicants submit that White's high temperature annealing step tends to destroy any persistent p-type characteristics of the material and converts it into an n-type or insulating material.

Applicants acknowledge that the pending claims are not directed to fabrication methods. However, the Examiner will appreciate that process conditions affect the resulting compound, and given that White's process is distinctly different than the processes disclosed in the present specification, one skilled in the art may conclude that the resulting compounds are different.

Because the experimental evidence provided by White suggests that White's arsenic-doped material is not "p-type," White does not "enable" one of ordinary skill in the art to prepare

arsenic doped "p-type" zinc oxide. A patent claim "cannot be anticipated by a prior art reference if the allegedly anticipatory disclosures cited as prior art are not enabled." *Elan Pharm., Inc. v. Mayo Found. for Med. Educ. & Research*, 346 F.3d 1051, 1054 (Fed. Cir. 2003). Because White fails to enable the preparation of a solid state device comprising a p-n junction containing a p-type group II-VI semiconductor material and an n-type semiconductor material, wherein the p-type group II-VI semiconductor comprises a single crystal thin film of a group II-VI semiconductor as recited in claim 1 and the devices of claims 23 and 42, Applicants submit that White fails to anticipate the invention disclosed and claimed in the instant application.

In view of the foregoing, Applicants submit that White fails to disclose each and every claim feature and element of claims 1, 23, and 42. Applicants further submit that claims 1, 23, and 42, and their dependent claims, are not anticipated by White.

Claim Rejections – 35 USC § 103. The Office Action rejected claims 10, 21, and 40 under Section 103(a) as being unpatentable over White et al. in view of Haga (U.S. Patent No. 6,838,308). Claims 13 and 29-30 were rejected under Section 103(a) as being unpatentable over White et al. in view of Yoshii et al. (U.S. Patent No. 6,707,074). Claims 17 and 36 were rejected under Section 103(a) as being unpatentable over White et al. in view of Merrin (U.S. Patent No. 3,864,725). Claim 41 was rejected under Section 103(a) as being unpatentable over White et al. in view of Harder et al. (U.S. Patent No. 5,331,655).

Haga. The Office Action states that the Haga patent discloses the ZnO layer disposed on an amorphous substrate. However, Haga fails to disclose those claim features that are missing in White. Hence, the combination of Haga and White fails to disclose each and every claim limitation. Therefore, the rejected claims 10, 21, and 40 would not have been obvious from the combined teachings of White and Haga.

Yoshii et al. The Office Action states that Yoshii et al. discloses ZnS, mixed crystal material, such as MgZnO, and CdO and MgO as Group II-VI semiconductor materials. However, the Yoshii et al. patent fails to disclose those claim features that are missing in White. Hence, the combination of Yoshii et al. and White fails to disclose each and every claim

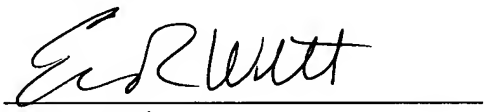
limitation. Therefore, the rejected claims 13 and 29-30 would not have been obvious from the combined teachings of White and Yoshii et al.

Merrin. The Office Action states that it is common in the art to form a pn junction type photodiode such as disclosed in Merrin. However, the Merrin patent fails to disclose those claim features that are missing in White. Hence, the combination of Merrin and White fails to disclose each and every claim limitation. Therefore, the rejected claims 17 and 36 would not have been obvious from the combined teachings of White and Merrin.

Harder et al. The Harder et al. patent was cited to reject claim 41 which recites a barrier layer disposed between the single crystal zinc oxide and the amorphous self supporting substrate. According to the Office Action, the Harder et al. patent discloses laser diode with a "barrier layer." Even if the Harder et al. patent discloses the barrier layer of claim 41, the Harder et al. patent fails to disclose those claim features that are missing in White. Hence, the combination of Harder et al. and White fails to disclose each and every claim limitation. Therefore, the rejected claim 41 would not have been obvious from the combined teachings of White and Harder et al.

Applicant respectfully requests withdrawal of the foregoing rejections and allowance of the pending claims. If there are any remaining issues preventing allowance of the pending claims that may be clarified by telephone, the Examiner is requested to call the undersigned.

Respectfully submitted,



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